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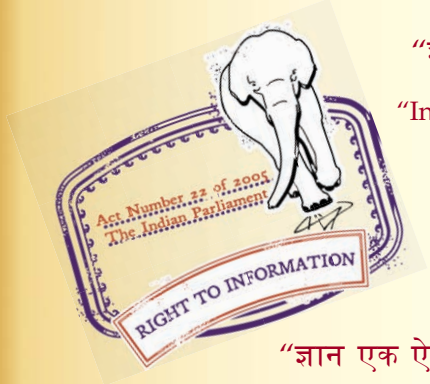
IS 4398 (1994): Carbon-chromium Steel for the Manufacture of Balls, Rollers and Bearing Races [MTD 16: Alloy Steels and Forgings]



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"Knowledge is such a treasure which cannot be stolen"

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IS 4398 : 1994
(Reaffirmed 2004)

भारतीय मानक

बॉल, रोलर और बेयरिंग रेसों के निर्माण के लिए कार्बन-क्रोमियम इस्पात — विशिष्टि

(दूसरा पुनरीक्षण)

Indian Standard

CARBON-CHROMIUM STEEL FOR THE MANUFACTURE OF BALLS, ROLLERS AND BEARING RACES — SPECIFICATION

(Second Revision)

UDC 669·15'26 - 194 : 621·822·7/·8

BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

August 1994 Price Group 4

Alloy Steel and Special Steels Sectional Committee, MTD 16

FOREWORD

This Indian Standard (Second Revision) was adopted by Bureau of Indian Standards, after the draft finalized by the Alloy Steel and Special Steels Sectional Committee had been approved by Metallurgical Engineering Division Council.

This standard was published in 1967 and revised in 1972. As a result of experienced gained during these years, it has been decided to revise this Indian Standard incorporating the following main modifications :

i) one more grade has been added,

ii) hardness requirements have been specified for coils and bars under various conditions of delivery, and

iii) requirements for inclusion rating have been modified.

For the benefit of purchaser of steels covered by this specification, an informative Annex A, giving particulars to be specified by the purchaser while ordering for these steels, has been given.

This standard contains clauses 5.1, Table 1 (Note), 8.2, 10.1, 10.2, 11.2, 13, 14.1, 14.1.1, 15.3, 15.4, and 17.2 which call for an agreement between the buyer and the seller and permit the purchaser to use his option for selection to suit his requirements.

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2:1960 'Rules for rounding off numerical values (*revised*)'. The number of significant places retained in rounded off value should be the same as that of the specified value in this standard.

Indian Standard

CARBON-CHROMIUM STEEL FOR THE MANUFACTURE OF BALLS, ROLLERS AND BEARING RACES — SPECIFICATION

(Second Revision)

1 SCOPE

This standard covers the requirements of four types of high carbon chromium steel in the form of billets, bars, wire rods, wire and rings to be used in the manufacture of ball and roller bearings for general purposes.

2 REFERENCES

The Indian Standards listed below are necessary adjuncts to this standard:

IS No.	*Title*
228	Methods of chemical analysis of steels (issued in parts)
1500 : 1983	Method for Brinell hardness test for metallic materials (*second revision*)
1586 : 1988	Methods for rockwell hardness test (B & C scales) for steel (*second revision*)
3739 : 1987	Dimensional tolerances for carbon and alloy constructional steel products (*first revision*)
4163 : 1982	Method for determination of inclusion content in steel by microscopic method (*first revision*)
4748 : 1985	Methods for estimating average grain size of metals (*first revision*)
6396 : 1983	Method of measuring decarburized depth of steel (*first revision*)
8910 : 1978	General technical delivery requirements for steel and steel products
11371 : 1985	Method for macroetch test of wrought steel products

3 SUPPLY OF MATERIAL

General requirements relating to the supply of material shall conform to IS 8910 : 1978.

4 MANUFACTURE

4.1 The steel shall be made by electric furnace process, fully killed and vacuum degassed or any other suitable process which shall meet the specified quality requirements.

4.1.1 For deoxidation and control of inclusion morphology, use of calcium or its compound is not permitted.

4.2 A sufficient reduction and discard shall be made from each ingot to ensure freedom from piping, segregation and other harmful defects.

4.3 The material may be conditioned to remove injurious surface defects by chipping, machining, grinding or any other suitable means at a suitable stage during reduction from the ingot to the finished size.

5 CHEMICAL COMPOSITION

5.1 The ladle analysis of steel shall be as given in Table 1. The analysis of steel shall be carried out either by the method specified in IS 228 and its relevant parts or any other established instrumental/chemical method. In case of dispute the procedure given in IS 228 and its relevant parts shall be referee method. However, where the method is not given in IS 228 and its relevant parts, the referee method shall be agreed to between the purchaser and the manufacturer.

5.1.1 Elements not specified in Table 1 shall not be added to the steel except when agreed to other than for the purpose of finishing the heat and shall not exceed the following limits:

Constituent	*Percent*
Nickel	0·25
Molybdenum	0·10
Copper	0·30
Vanadium	0·05
Titanium	0·000 45

5.2 Product Analysis

5.2.1 Product analysis shall be carried out on finished product. The permissible variation in the case of product analysis from the limits specified in Table 1 shall be as given in Table 2.

6 CONDITION OF DELIVERY

6.1 Unless specified otherwise, steel shall be supplied in fully spheroidized annealed condition.

7 MICROSTRUCTURE

7.1 The annealed material shall show a completely spheroidized structure of uniformly distributed smell globular carbides (*see* Fig. 1). The acceptable spheroidized structure shall be as given for Grades 2, 3 and 4 in Fig. 1.

7.1.1 The structure shall be free from excessive segregation and shall not reveal presence of carbides in cellular form (*see* Fig. 2). The acceptable limits for carbide banding shall be as for Grades 1 and 2 given in Fig. 2.

Table 1 Chemical Composition
(*Clause* 5.1)

Grade Designation	Constituent Percent					
	C	Si	Mn	P	S	Cr
(1)	(2)	(3)	(4)	(5)	(6)	(7)
104Cr6	0·98 to 1·10	0·15 to 0·35	0·25 to 0·45	0·025	0·025	1·30 to 1·40
103Cr6	0·95 to 1·10	0·15 to 0·35	0·60 to 0·80	0·025	0·025	1·50 to 1·70
103Cr4Mn4	0·95 to 1·10	0·40 to 0·70	0·90 to 1·15	0·030	0·025	0·90 to 1,20
98Cr6Mn4	0·90 to 1·05	0·5 to 0·70	1·0 to 1·20	0·030	0.005	1·40 to 1·65

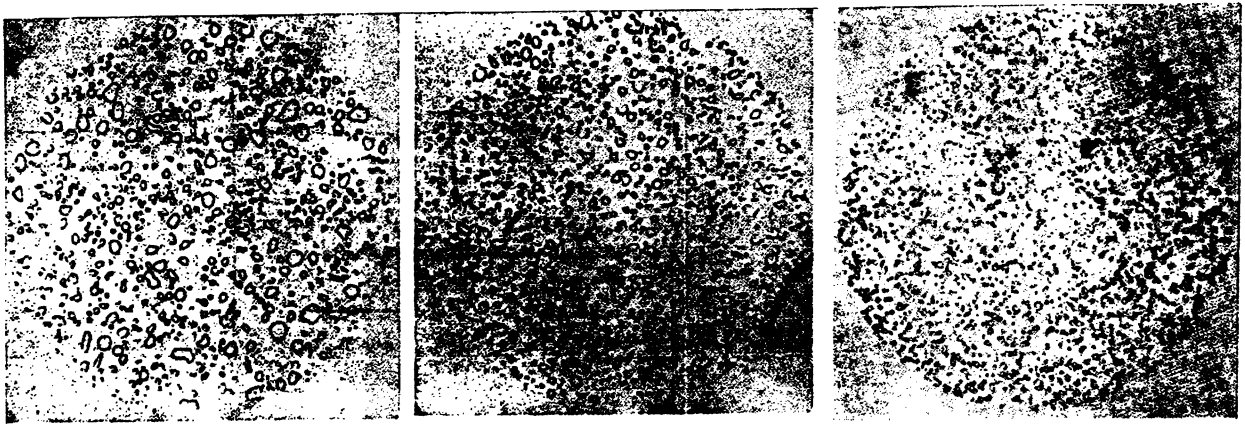
NOTES

1. The desirable oxygen content should be 15 ppm *Max*, however, if any from this limit and the method of test shall be mutually agreed to between the purchaser and the manufacturer.
2. In special cases, it may be desirable that the range of carbon content should be more closely controlled than the ranges specified above. When this is necessary, restricted range of carbon may be agreed to between the purchaser and the manufacture.

Table 2 Permissible Variation for Product Analysis
(*Clause* 5.2)

Constituent	Maximum Specified Range Percent	Variation Percent
Carbon	–	±0·03
Manganese	–	±0·03
Silicon	–	±0·02
Sulphur	–	+0·005
Phosphorus	–	+0·005
Chromium	Up to 0·90	±0·03
	over 0·90	±0·05

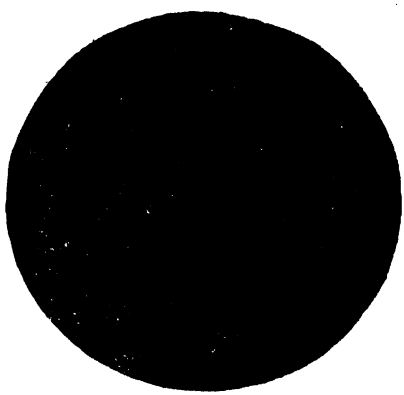
NOTE — '±' means that in one cast the deviation may occur over the upper value or under the lower value of the specified range in Table 1.



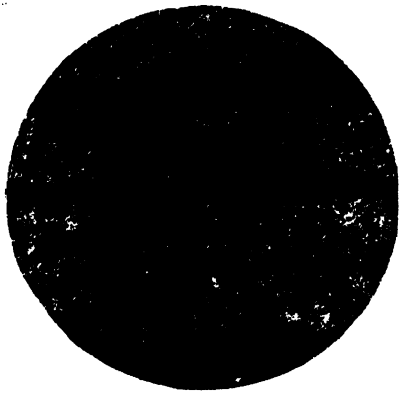
Grade 1 Very Coarse | Grade 2 Coarse | Grade 3 Fine

Grade 4 Fine | Grade 5 Very Fine | Grade 6 Extremely Fine

FIG. 1 SPHEROIDIZED ANNEALED STRUCTURE (Magnification 1 000 ×)

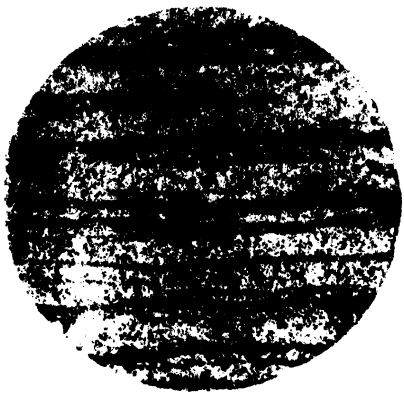


GRADE 1



GRADE 2

GRADE 3



GRADE 4

FIG. 2 CARBIDE BANDING (Magnification 100 ×)

7.2 The internal stress condition shall not be such as to cause undue distortion after machining.

8 HARDNESS

8.1 The hardness of steel when tested in accordance with IS 1500 : 1983 and IS 1586 : 1988 shall be as follows :

Product	*Condition*	*Maximum hardness*
Coils	Hot rolled, annealed	92 HRB
Bars	Hot rolled annealed	207 HBS
Coils	Annealed, cold drawn (stress relieved)	92 HRB
Coils & Bars	Annealed, cold drawn	250 HBS

8.2 In case of cold drawn wire for cold heading process, the hardness shall be mutually agreed to between the purchaser and manufacturer.

9 INCLUSION CONTENT

9.1 The inclusion rating of the standard test billet shall be determined in accordance with IS 4163 : 1982. The worst field of each inclusion from each specimen shall be recorded as a rating for the specimen. The inclusion rating of the specimen shall not exceed the limits specified in Table 3.

NOTE - Two thirds of all specimens and at least one from each ingot tested, as well as the average of all specimens, shall not exceed the rating specified in Table 3.

Table 3 Inclusion Rating
(Clause 9)

	Thin series	Heavy series
Rating Unit	A 2 1/2 B 2 C 1/2 D 1	A 1 1/2 B 1 C 1/2 D 1
NOTE –	A – Sulphides C – Silicate	B – Alumina D – Globular oxide

10 DECARBURIZATION AND SURFACE DEFECTS

10.1 Decarburization and surface defects shall be kept to the minimum. Subject to mutual agreement between the purchaser and the manufacturer, the depth of decarburization shall be measured in accordance with IS 6396 : 1983. The limit for decarburization and surface defects shall be as specified in Tables 4 and 5.

NOTE — In case of rings the limits for decarburization and surface defects shall be mutually agreed to between purchaser and manufacturer.

Table 4 Decarburization and Surface Defects in Bars
(Clause 10.1)
All dimensions in millimetres.

Dimension		Decarburization or Surface Defects per Side, *Max*		
Over	Up to and Including	Hot-Rolled	Annealed	Cold Finished
–	25	0·30	0·38	0·30
25	50	0·43	0·56	0·38
50	75	0·64	0·76	0·64
75	100	0·89	1·14	–
100	–	1·40	1·65	–

Table 5 Decarburization and Surface Defects in Wire Rod and Wire
(Clause 10.1)
All dimensions in millimetres.

Dimension		Decarburization or surface Defects per side, *Max*	
Over	Up to and Including	Hot-Rolled or Hot-Rolled and Annealed	Cold Finished
–	5	0·05	0·04
5	6	0·13	0·08
6	12·5	0·15	0·10
12·5	19	0·20	0·15
19	25	0·25	0·25

10.2 For special applications, such as for needle bearing industry, the material may be supplied with lower decarburization limits as mutually agreed to between the purchaser and the manufacturer.

10.3 The fracture shall show fine grains approximately equal to 8 as specified in IS 4748 : 1985.

11 FRACTURE TEST

11.1 Test specimen, approximately 10 mm in thickness, representative of the cross section of billets for forging and rerolling into coils and bars shall be normalized, annealed and hardened by quenching in oil from a temperature of 830 ± 5°C, and fractured. The fractured surfaces when examined visually, shall be free from any of the following defects:

a) Presence of more than one non-metallic inclusion of 1·6 to 3 mm in length;

b) Presence of one non-matallic inclusion over 3 mm in length; and

c) Presence of porosity, pipe or internal cracks.

11.2 The fracture shall show fine grains. The grain size shall be subject to mutual agreement between the purchaser and the manufacturer.

12 MACRO ETCH TEST

12.1 When tested in accordance with IS 11371 : 1985, the steel shall be free from pipe, excessive porosity, segregation and any other harmful inclusions.

13 ADDITIONAL TESTS

13.1 Subject to mutual agreement between the purchaser and the supplier, any other special tests may also be specified at the time of enquiry and order.

14 DIMENSIONAL TOLERANCES

14.1 Unless specified otherwise, dimensional tolerances for hot rolled bars and wire rods shall conform to Grade 1 tolerances of IS 3739 : 1987. Dimensional tolerances for cold finished bars and wires shall be as given in Table 6 and 7. The wire rod tolerances shall be as agreed to between the purchaser and the manufacturer.

14.1.1 For special applications, such as for the manufacture of needle bearings, the tolerances shall be as agreed to between the purchaser and the manufacturer.

14.2 Tolerances on Length

The length of bars and the tolerance on length shall be as given in IS 3739 : 1987.

14.3 Bars shall be supplied with the ends cuts square.

Table 6 Tolerances for Cold Finished Bars
All dimensions in millimetres.

Dimension		Tolerance	
Over	Up to and Including	Minus	Plus
–	38	0·13	Nil
38	63	0·15	Nil
63	100	0·18	Nil

14.4 Tolerance on Straightness

The deviations from true straightness shall not exceed 1 mm per 750 mm length. Specially treated bars shall obey the tolerances laid down in IS 3739 : 1987.

Table 7 Tolerances for Cold Finished Wires
(*Clause* 14.1)
All dimensions in millimetres.

Dimension		Total Tolerance
Over	Up to and Including	
–	2·5	0·05
2·5	6·70	0·08
6·70	19	0·10

15 SAMPLING

15.1 Chemical Analysis

The ladle analysis shall be supplied by the manufacturer. If check analysis is required, at least one sample product shall be taken from each cast.

15.2 Hardness Test

One sample shall be taken from each size of each heat-treatment batch representing one cast. If the material is continuously heat-treated, one sample shall be taken from every lot or part thereof, but at least one sample from each cast shall be taken.

15.3 Test for Inclusion Rating

For top poured products, a minimum of six samples representing the top and bottom of the first, middle, and last usable ingots shall be examined.

For bottom poured products, a minimum of six samples shall be examined and they shall represent the top and bottom of three ingots. One ingot shall be taken at random from the first usable plate poured, one in got, at random, from the next to last usable plate poured. When two usable plates constitute a heat, two of the sample ingots poured. Where a single usable plate constitutes a heat, any three random ingots may be selected. Other methods of sampling shall be as agreed upon by manufacturer and purchaser.

15.4 Decarburization and Macro-Etch Test

The number of samples to be tested and the mode of taking test samples shall be subject to mutual agreement between the purchaser and the manufacturer.

16 RETEST

16.1 Should any of the test piece fail to pass any of the tests specified, two further test samples shall be taken for testing in respect of each failure. In case of product analysis, the new samples shall be taken from different pieces from the same cast. In case of physical tests, the new samples shall be selected from the same heat-treatment batch. Should either of the retests fail to meet the specified requirements, the batch represented shall be deemed as not conforming to the standard. However, if the failure is with respect to physical test, the batch may be further heated and offered for further testing.

17 MARKING

17.1 Each bar over 50 mm dia or of equivalent cross section and each billet shall be stamped at one face with the cast number or any other identification mark by which the steel could be traced to the cast from which it was made.

17.2 Bars of 50 mm dia and below, wires and wire rods shall be bundled as agreed to between the purchaser and the manufacturer. The tag attached to each bundle shall be marked with the information as given in 17.1.

17.3 Rings shall be supplied in boxes duly marked with information given in 17.1.

17.4 The material may also be marked with Standard Mark.

17.4.1 The use of the Standard Mark is governed by the provisions of *Bureau of Indian Standards Act, 1986* and the Rules and Regulations made thereunder. The details of conditions under which a licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

ANNEX A

(Foreword)

INFORMATION TO BE SUPPLIED BY THE PURCHASER

A-1 BASIS FOR ORDER

A-1.1 While placing an order for high carb-on-chromium steel for bearing covered by this standard, the purchaser should specify the following:

a) Type or grade designation;
b) Method of manufacture;
c) Size;
d) Length;
e) Condition;
f) Tests report;
g) Surface treatmcnt and mode of packing; and
h) Special requirements, if any.

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Amend No	Date of Issue	Text Affected

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TO
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(Second Revision)

(*Page* 2, *Table* 1, *col* 5) — Insert '*Max*' below col No. 5.

(*Page* 2, *Table* 1, *col* 6) — Insert '*Max*' below col 6.

(*Page* 2, *Table* 1, *col* 7, *row* 3) — Substitute '1.60' for the existing

(*Page* 2, *Table* 1, *col* 6, *row* 10) — Substitute '0.025 ' for the existing

(*Page* 2, *Table* 1, *Note* 1, *line* 1) — Insert 'deviation' after the word 'any'.

(MTD 16)

Reprography Unit, BIS, New Delhi, India